(12) UK Patent Application (19) GB (11) 2 168 537 A

(43) Application published 18 Jun 1986

(21) Application No 8530508

(22) Date of filing 11 Dec 1985

(30) Priority data
(31) 59/262605 (32) 12 Dec 1984 (33) JP

(71) Applicant
Shin-Etsu Polymer Co Ltd (Japan),
11 Nikonbashi-honcho 4-chome, Chuo-ku, Tokyo, Japan

(72) Inventors
Masayuki Mitsuhashi
Naoto Komine
Takao Shimizu

(74) Agent and/or Address for Service
D Young & Co,
10 Staple Inn, London WC1V 7RD

(51) INT CL⁴
H01H 13/70

(52) Domestic classification (Edition H):
H1N 543 618 626 637 700 704 705 854 BG BH

(56) Documents cited
GB A 2130016 GB A 2036442

(58) Field of search
H1N
Selected US specifications from IPC sub-class H01H

(54) Push button switch covering member

(57) The invention provides an elastomeric push button switch covering member having a dome-like configuration integrally composed of a base portion (5), a top portion (2) and a riser portion (4) connecting the base portion and the top portion. By virtue of the specific elastic properties of the elastomer with a Shore D hardness of at least 35 or, preferably, in the range from 35 to 60 and a rebound of at least 40%, the covering member can give the operator's finger tip a very definite and reliable clicking sensation.

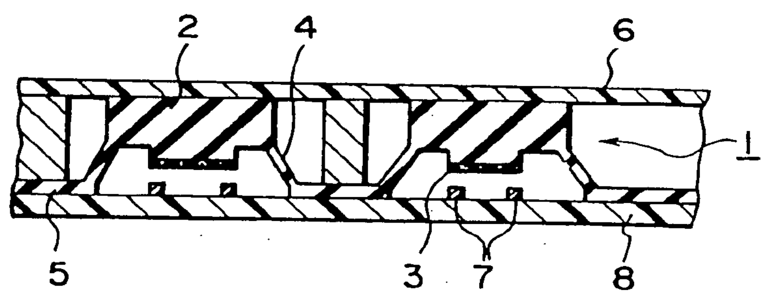

FIG. 2

GB 2 168 537 A

SPECIFICATION

Push button switch covering member

The present invention relates to a push button switch covering member, more particularly, a push button switch covering member composed of a base portion, a top portion and a riser portion connecting the base portion and the top portion into a dome-like configuration. Preferably, the switching stroke does not exceed 0.5 mm and the click ratio is at least 30% to ensure highly efficient switching with good reliability and a pleasant touch sensation on the operator's finger tip.

In recent years, flat-panel key board switches have been widely used, for example, in various kinds of input switches including remote control switching units. In view of the usually very small switching stroke in such flat-panel key board switches, it is essential that the switching operation of the switch can be definitely recognized by pushing the switch with a finger tip. Such a recognition can be obtained in several different ways including light and sound signals although the most preferable and reliable way is that the finger tip receives a clearly recognizable clicking sensation from the key top.

Push button switch covering members are sometimes made of a relatively rigid material in order to prevent deformation and slackening after use for a prolonged period of time so that the switching stroke of a key board switch having such a covering member can rarely be larger than 0.2 to 0.5 mm. When the switching stroke is so small, conventional rubber push button switches can hardly give the pushing finger tip a definite and reliable clicking sensation. This is expressed by the click ratio defined by $(a-d)/a \times 100$ (%), in which 'a' is the pushing load at the peak and 'd' is the pushing load at the moment of clicking in the pushing stroke vs. pushing load diagram.

A solution for the above mentioned problem is obtained by the use of a resilient diaphragm made of a metal such as German silver, phosphor bronze, stainless steel and the like in a downwardly concave configuration as a movable contact member facing the fixed contact points therebelow and coming into contact therewith when pressed down. Such a resilient metal diaphragm member can give a quite good clicking sensation with a click ratio as high as 46.7% by the reversal of the curvature at a certain point in the course of increase of the pushing load. A problem of such a push button switch is low reliability and durability due to fatigue of the metal diaphragm which may fail to regain the original unpressed configuration after clicking takes place and dust particles entering between the fixed contact point and the diaphragm so causing failure in establishing electric connection therebetween. Moreover, another disadvantage is that productivity in the assembly of push button switches of such a metal diaphragm type cannot be high enough because each push button switch must contain a metal diaphragm inserted between the covering member and the base board with accurate positioning to ensure centering of the pushing load relative to the diaphragm. There are also problems caused by the increased number of parts to be assembled into such a push button switch.

The push button switch covering member of the invention is a member having a dome-like configuration as a whole integrally composed of a base portion, a top portion and a riser portion connecting the base portion and the top portion into a dome-like form and made of a rubbery elastomer having a Shore D hardness of at least 35 and preferably in the range from 35 to 60, and a rebound of at least 40%.

Preferred embodiments of the invention will now be described with reference to the drawings in which:–

Figure 1 illustrates pushing stroke vs. pushing load diagrams in various types of push button switches.

Figure 2 to *6* are each a vertical cross sectional view of a push button switch covering member of the invention and *Figures 7* and *8* are each a vertical cross sectional view of a conventional diaphragm type push button switch either without pushing or as depressed by pushing, respectively.

In the first place, the problems in the conventional push button switches are described with reference to the accompanying drawing. The diagram A in Fig. 1 shows the pushing stroke vs. pushing load relationship given for the purpose of explanation of the click ratio as defined herein, in which the height 'a' corresponds to the maximum pushing load in the course of the increase of the pushing stroke before clicking takes place and the height 'd' corresponds to the pushing load at the moment when clicking takes place in the course of the increase of the pushing stroke after the maximum pushing load 'a'. As is mentioned above, the click ratio in % is given by $(a-d)/a \times 100$ and a better clicking sensation is obtained when the click ratio is sufficiently large.

Fig. 7 illustrates a vertical cross sectional view of a conventional diaphragm type push button switch composed of a surface panel sheet 21 bearing a pushing head 22 on the lower surface thereof and mounted on a printed circuit board 23 having a pair of fixed contact points 24 and

a metal downwardly concave resilient diaphragm 25 between the pushing head 22 and the circuit board 23 and held by a holder piece 26. When the surface panel sheet 21 is depressed with a finger tip at a position just above the pushing head 22 as is illustrated in Fig. 8, the curvature of the diaphragm 25 is clickingly reversed to give a considerably high click ratio even with a low pushing stroke. The push button switches of this type, however, have various problems and disadvantages as discussed above.

In contrast to the above described push button switches of the diaphragm type, a push button switch having a typical covering member of the invention illustrated in Fig. 2 has no such diaphragm. The covering member 1 mounted directly on a printed circuit board 8 having a pair of fixed contact points 7 is integrally composed of a base portion 5 contacting the circuit board 8, a top portion 2 bearing a movable contact point 3 on the lower surface thereof and a relatively thin-walled riser portion 4 connecting the base portion 5 and the top portion 2 into a dome-like configuration. It is usual that a covering member 1 having a plural number of the above described units is covered with a surface panel sheet 6 indicating the pushing positions. The covering member 1 is formed from a rubbery elastomer having the above specified Shore D hardness and rebound value.

When the top portion 2 of the covering member 1 is pushed down and depressed directly or through the surface panel sheet 6 as is illustrated in Fig. 3, the riser portion 4 is deformed with buckling to bring the movable contact point 3 into contact with the fixed contact points 7 below to connect the fixed contact points 7 electrically. It is important in this case, in order that the operator's finger tip receives a definite and reliable feeling of click switching, that the buckling of the riser portion 4 should take place as suddenly as possible and that the buckled riser portion 4 exhibits a resilience by virtue of the elastic behavior thereof. Such conditions are satisfied when the rubbery elastomer of which the covering member 1 is shaped has a Shore D hardness of at least 35 or, preferably, from 35 to 60 and a rebound of at least 40%.

When the covering member 1 illustrated in Fig. 2 is formed from an elastomer having a Shore D hardness of 40 and a rebound of 62%, for example, the switching operation gives a pushing stroke vs. pushing load diagram as illustrated by the curve H in Fig. 1 from which the click ratio can be calculated to give a value of 72.4%. When the covering member 1 is made of a silicone rubber having a Shore A hardness of 60 corresponding to a Shore D hardness of 20 to 25 and a rebound of about 60%, on the other hand, the pushing operation thereon gives the pushing stroke vs. pushing load diagram C of Fig. 1. Although the click ratio calculated from the diagram C is 60%, the absolute value of clicking is small due to the low peak value of the pushing load as a result of the low hardness of the rubber so that the clicking sensation received by the operator's finger tip is not always definite and reliable. When the wall thickness of the riser portion 4 in such a silicone rubber-made covering member 1 is increased in order to have a larger absolute peak value of the pushing load, the click ratio is decreased almost to zero as will be seen from the diagram D in Fig. 1 due to the decreased suddenness of the buckling deformation, so that the operator's finger tip receives no clicking sensation.

When the push button switch covering member 1 as illustrated in Fig. 2 is formed from an elastomer having a Shore D hardness of 35 and a rebound of 39% to give the stroke vs. load diagram E of Fig. 1, the click ratio calculated from the diagram is 20.8%. This gives the operator's finger tip a clicking sensation to some extent but without sufficient definiteness and reliability.

Instead of the typical assembly illustrated in Fig. 2 with a surface panel sheet 6 covering all the key board switching panel, a key top piece 9 made of a relatively rigid material may be put on each of the switch units in contact with the flat top portion 2 of the covering member 1 as is illustrated in Fig. 4. Furthermore, by virtue of the high hardness of the rubbery elastomer from which the covering member 1 is formed, the top portion and the key top piece may be formed integrally from the same rubbery elastomer to give an integral flat top portion 10 as is illustrated in Fig. 5.

Fig. 6 illustrates another embodiment of the push button switch covering member of the invention which, in contrast to the embodiment illustrated in Figs. 2 to 5, has no movable contact point on the lower surface of the flat top portion 2. Instead, a flexible insulating membrane 11 made of, for example, a polyester film, is inserted between the circuit board 8 bearing the fixed contact points 7 thereon and the covering member 1 with a spacer 12 between the circuit board 8 and the flexible membrane 11 and the movable contact point 3 is provided on the lower surface of the flexible membrane 11 by the technique of printing with an electroconductive ink or other suitable means.

The push button switch covering member of the invention can be made by compression molding, injection molding or the like using an elastomer stock having the specified Shore D hardness and rebound. Such an elastomer stock may for example be first shaped into a sheet-like preform which is then shaped into the desired form of the covering member by vacuum forming or pressure forming. The type of elastomer is not particularly significant provided that the elastomer has the specified Shore D hardness and rebound. Examples of suitable elastomers

are polyamide-polyether copolymeric rubbers, polyester-polyether compolymeric rubbers, polyurethnes, polyolefins, styrene-butadiene copolymeric rubbers, fluorocarbon elastomers and the like.

Following is an example to illustrate the push button switch covering member of the invention in more detail.

Example.

Several push button switch covering members E, F, G and H having a configuration illustrated in Fig. 2 were made using several different elastomer stocks having a Shore D hardness of 35 to 46 and a rebound of 44 to 62% including a thermoplastic polyamide-polyether copolymeric elastomer and a thermoplastic polyurethane elastomer. The covering member had dimensions of 6 mm for the diameter of the top flat, 0.5 mm for the overall pushing stroke, 0.08 mm for the wall thickness in the riser portion and 60° for the rising angle of the riser portion relative to the base portion. These covering members were each subjected to the test for the pushing stroke vs. pushing load relationship to give the results shown in Table 1 below and by the diagrams E, F, G and H, respectively, in Fig. 1.

For comparison, further covering members C and D having the same configuration and dimensions as above except that the wall thickness of the riser portion was 0.08 mm mm, respectively, were prepared using a silicone rubber having a Shore D hardness of 20 and a rebound of 65%. The results of the tests for the pushing stroke vs. pushing load relationship performed on these comparative covering members are shown also in Table 1 and by the diagrams C and D, respectively, in Fig. 1. Further for comparison, a diaphragm type push button switch B as illustrated in Fig. 7 was made using a membrane of German silver. The result of the test for the pushing stroke vs. pushing load relationship undertaken of this push button switch B is shown in Table 1 and by the diagram B in Fig. 1.

Table 1

Switch No.		G	H	F	E	D	C	B
Rubber	Type *1	I	I	II	II	III	III	*2
	Hardness, Shore D	35	40	46	35	20	20	-
	rebound, %	65	62	44	39	65	65	-
Peak load, g		180	196	224	212	204	20	244
Feeling of clicking touch	Click ratio, %	53.3	72.4	33.0	20.8	0	60	46.7
	Organoleptic	Good	Good	Good	Fair	Poor	Poor	Good

*1. I: polyamide-polyether copolymer; II: urethane rubber; III: silicone rubber

*2. metal diaphragm type

CLAIMS

1. A push button switch covering member having a dome-like configuration as a whole integrally composed of a base portion, a top portion and a riser portion connecting the base portion and the top portion and made of a rubbery elastomer having a Shore D hardness of at least 35 and a rebound of at least 40%.

2. The push button switch covering member as claimed in claim 1 wherein the Shore D hardness of the rubbery elastomer is in the range from 35 to 60.

3. The push button switch covering member as claimed in claim 1 substantially as described with reference to any of Figs. 2 to 6 of the drawings.

4. A push button switch assembly comprising a covering member as claimed in any preceding claim.

Printed in the United Kingdom for Her Majesty's Stationery Office, Dd 8818935, 1986, 4235.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1/3

2168537

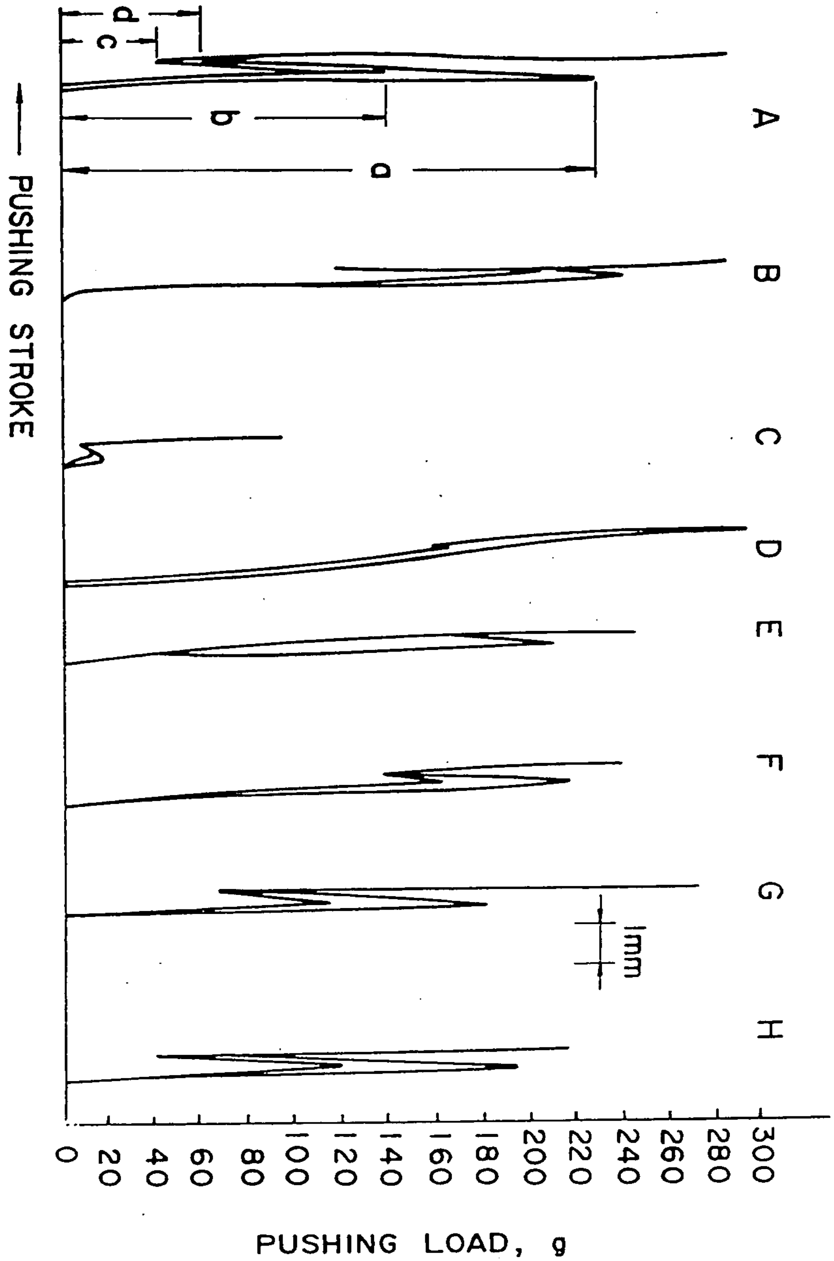

FIG. I

FIG. 2

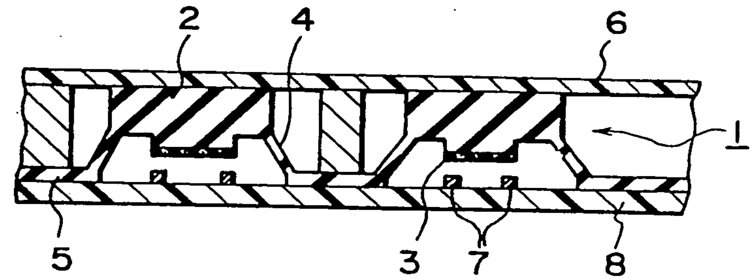

FIG. 3

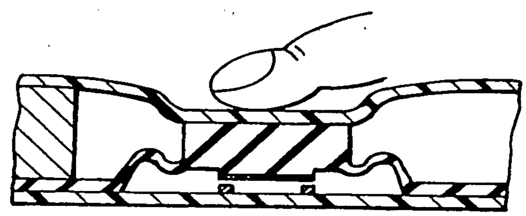

FIG. 4

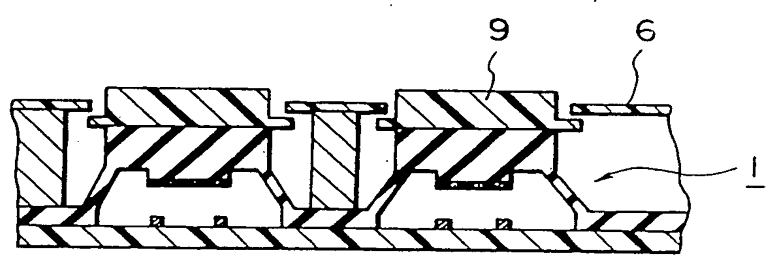

FIG. 5

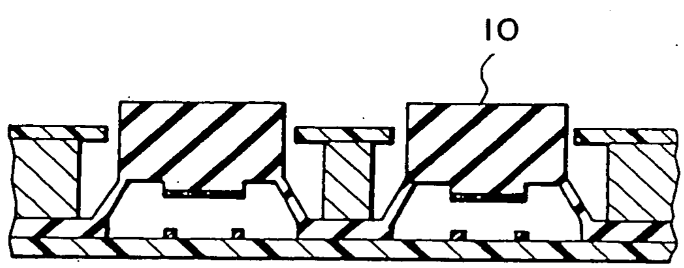

FIG. 6

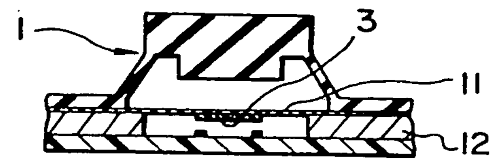

FIG. 7

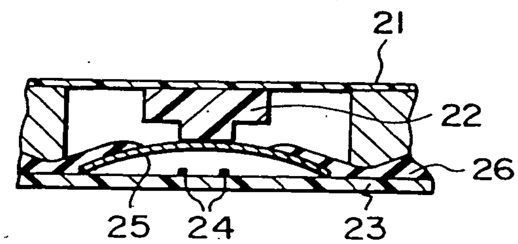

FIG. 8